

Support of the Mariner 10 Television Enhancement Experiment

J. E. Allen
Network Operations

This article describes the support provided by DSN Operations for the Mariner 10 Television Enhancement Experiment that was conducted during the second Mercury encounter. The experiment included antenna arraying at the Goldstone Deep Space Stations (DSSs 12, 13, and 14) and signal combining at DSS 14 of the spacecraft's uncoded 117.6-kbps high-rate telemetry data. In addition, analog recordings of symbol synchronizer assembly outputs were made at DSSs 14 and 43 during the encounter pass view period overlap for later processing and correlation at JPL to improve the video data beyond the quality that could be obtained from a single recording.

I. Introduction

During the second Mercury encounter, more than 500 photographs were taken by the Mariner 10 spacecraft. As with the first encounter, the mission profile required real-time evaluation of video data at JPL. This required the DSN to reestablish the capability of formatting the high-rate telemetry data (117.6 kbps) at DSS 14 and transmitting the data to JPL in real-time. Additionally, in response to a Mariner 10 Project request and with TDA office concurrence, the DSN supported a research and development (R&D) TV Enhancement Experiment.

II. Wideband Data Transmission Capability

The 230-kbps wideband system, which is described in detail in Ref. 1, was removed from DSS 14 in April 1974 with the understanding that it would not be needed for the second Mercury encounter (ME II). Subsequently, however, the decision was made to provide the same support for ME II that was provided for the first encounter.

The wideband system was reinstalled at DSS 14 under the authority of Engineering Change Orders (ECO) 74.191

and 74.192. Equipment was delivered to DSS 14 on August 19, 1974, and installation and checkout were completed on September 1, 1974. Data flow tests with live spacecraft data were conducted from September 3 through September 5, 1974. In summary, the wideband system was installed and declared operational in only 15 days.

III. Television Enhancement Experiment

A. Purpose

The overall purpose of the TV enhancement experiment (Fig. 1) was to improve the quality of the television pictures received from the spacecraft during ME II. This was accomplished by arraying the antennas at Goldstone DSSs 12, 13, and 14 and combining the signals at DSS 14 for real-time transmission to JPL at Pasadena. In addition to the antenna arraying, DSS 14 and DSS 43 produced analog recordings of the Symbol Synchronizer Assembly (SSA) integral bit values for post-encounter cross-correlation of the recordings at JPL to achieve improvement in the quality of the video data.

B. Antenna Arraying and Signal Combining

DSSs 12, 13, and 14 operated in the low-noise, listen-only mode (no uplink was required during the encounter pass). The receiver baseband data from DSSs 12 and 13 were microwaved to DSS 14. The DSS 14 receiver baseband data were microwaved to the Communications Switching Center at Goldstone (GCF 10) and back to DSS 14 to realize the required signal delay. The microwaved signals were then phased and mixed at DSS 14 by using an R&D signal combiner device. The R&D signal combiner then outputted the telemetry signal to the Subcarrier Demodulator Assembly (SDA) for up-conversion and normal data handling by one of DSS 14's two data handling equipment strings to produce digital Original Data Records (ODR) and transmission to JPL. In parallel with this activity, the other data handling string was used for normal data processing and recording of telemetry data. Under the authority of ECO 74.189, the multiple antenna signal combiner and the microwave link were assembled and installed at Goldstone by September 3, 1974.

C. Results of Antenna Arraying

Pre-encounter testing took place from September 3 through September 10, 1974. In-flight testing was conducted from September 10 through September 20, 1974. During the in-flight testing, signal-to-noise ratio (SNR) improvement due to antenna arraying was observed

to vary from 0.1 to 1.2 dB. The average SNR improvement was 0.60 dB. The improvement was measured by comparing the SNR from the combined signal with the SNR from the uncombined signal from DSS 14 and calculating the average difference. On encounter day, the average improvement in SNR with the combined signal was observed and reported by the Mariner project representative as being 0.35 dB.

It has been theorized that the difference between the SNR improvements obtained on encounter day (0.35 dB) and the SNR improvement obtained during the in-flight testing (0.60 dB) probably can be attributed to differences in the methods used to take the measurements. The in-flight test measurements were plotted from the bit error rate (BER) output of the Mission Test/Telemetry Computing Facility. On encounter day, the SNR was extracted directly from the telemetry data stream.

Throughout the Mariner mission, the SNR extracted from the telemetry stream has been averaging 0.2 dB lower than the SNR obtained by using the theoretical BER curves. Therefore, by adding the 0.2 dB to the SNR observed on encounter day, the telemetry SNR improvement due to antenna arraying would have been 0.55 dB, or approximately the same as was observed during the in-flight testing (0.60 dB). The SNR differences are still under investigation by the Project's telecommunication representative.

D. Real-Time Operations

The TV Enhancement Experiment operation was conducted under the direction of the experiment's team leader from Division 33. DSN Operations coordinated and controlled the overall operation and provided the following special operational capabilities for conducting the experiment:

- (1) An internal voice net between the experiment team leader at DSS 14 and the receiver operators at DSSs 12 and 13.
- (2) A voice net between the team leader at DSS 14 and an experiment project advisor at JPL. All operational communications between the Mariner Project and the enhancement experiment were conducted through this link.

The DSN established as a guideline that, in the event of a failure of the prime telemetry string at DSS 14, the Station Operations Supervisor, after normal coordination with the flight project via Net Control, would reconfigure the string being used for the experiment to provide operational support. This did not happen because the

operational telemetry string and the enhancement string operated without any failures.

E. Non-Real-Time TV Enhancement Experiment

In non-real-time, dedicated recorders (occultation recorders) were made available to produce special recording of SSA integral bit values during the overlap periods at DSSs 14 and 43. The output of the SSA J-2 port was cabled to the FR 1400 recorder for 7-channel

recording of significant bit values. The analog tapes were delivered to the Project for processing at JPL. As of this time, the recordings have not been processed.

Equipment modifications for supporting the non-real-time portion of the TV Enhancement Experiment were completed at DSSs 14 and 43 under ECO 74.214 on 14 September 1974.

Reference

1. Hatch, J. T., and Capps, J. W., "Real-Time High-Rate Telemetry Support of Mariner 10 Operations," in *The Deep Space Network Progress Report 42-23*, pp. 125-131, Jet Propulsion Laboratory, Pasadena, California, July and August 1974.



Fig. 1. DSN Mercury II TV Enhancement Experiment configuration